OPTIMAL OPTICS IN COMPLEX ENVIRONMENTS

Allard P. Mosk
Nanophotonics, Debye Institute for Nanomaterials Science,
Utrecht University, The Netherlands
E-mail: a.p.mosk@uu.nl

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Random scattering of light, which takes place in paper, paint and biological tissue is an obstacle to imaging and focusing of light and thus hampers many applications. At the same time scattering is a phenomenon of basic physical interest and its relation to the information content of light is subtle [1] and in many cases focusing and imaging are still possible [2]. Here we show shaped light fields that are relevant to imaging and measurements in scattering environments. Firstly, we present **maximum information states**, which are light states that carry a maximum amount of information about a given observable, enabling the most precise measurements that are possible given a coherent input beam [3]. Conversely**, scattering invariant modes** are the least sensitive modes to the presence of a scattering sample and they retain the same output profile whether propagated through a scattering material or through air, as visualized in Fig. 1. We demonstrate these states experimentally and show numerically their relevance to imaging inside scattering media [4].

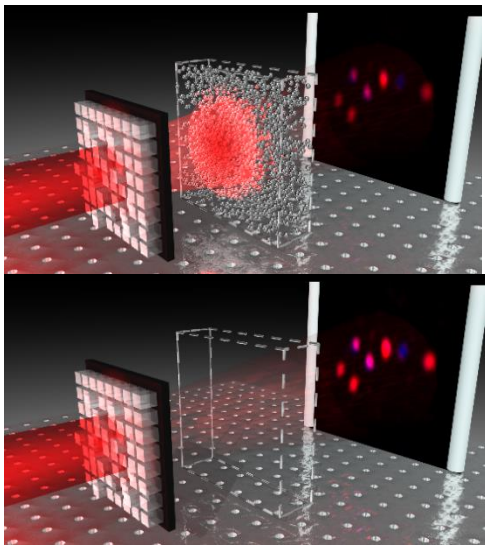

Fig. 1. Principle of scattering invariant modes (SIMs. Top: A SIM incident on a scattering medium has a certain transmitted field which is shaped exactly the same as when the same filed is transmitted through air (bottom).

References

[1] A. P. Mosk, A. Lagendijk, G. Lerosey, and M. Fink, *Controlling waves in space and time for imaging and focusing in complex media*, Nat. Photon., **6,** 283 (2012).

[2] I.M. Vellekoop and A.P. Mosk, *Universal optimal transmission of light through disordered materials,* Phys. Rev. Lett. **101**, 120601 (2008).

[3] D. Bouchet, S. Rotter and A.P. Mosk, *Maximum information states for coherent scattering measurements,* Nature Physics (2021). DOI: 10.1038/s41567-020-01137-4

[4] P. Pai, J. Bosch, M. Kühmayer, S. Rotter and A.P. Mosk, *Scattering invariant modes of light in complex media,* arXiv:2010.01075 (2020).